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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/563,634

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Shouichi Koga

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EXAMINER

FOTAKIS, ARISTOCRATIS

ART UNIT

PAPER NUMBER

2611

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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

### Office Action Summary

**Application No.**

10/563,634

**Applicant(s)**

KOGA ET AL.

**Examiner**

ARISTOCRATIS FOTAKIS

**Art Unit**

2611

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 01/06/2006.  
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1 - 23 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.  
5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.  
6) ☒ Claim(s) 1 - 23 is/are rejected.  
7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.  
10) ☒ The drawing(s) filed on 06 January 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)  
3) ☒ Information Disclosure Statement(s) (PTO-8508)  
Paper No(s)/Mail Date 01/06/2006  
4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_  
5) ☐ Notice of Informal Patent Application  
6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 - 3, 5 - 6, 13 - 14 are rejected under 35 U.S.C. 102(b) as being anticipated by Wong et al ("A Joint Channel Diagonalization for Multiuser MIMO Antenna Systems" IEEE Transactions on Wireless Communications, Vol 2, No.4, July 2003).

Re claims 1, Wong teaches of a wireless communication system comprising: a base station (BS, Fig.1); a plurality of terminals (Ms1 – MSM, Fig.1); and a control unit (multiuser channel diagonalization, Abstract), wherein said base station and each of said plurality of terminals are operable to simultaneously perform space division multiplex wireless transmission of information using a same frequency (SDM, Page 773), wherein at least one of said plurality of terminals communicates with said base station via a plurality of propagation paths (Fig.1), wherein said base station comprises a base station multi-beam antenna (Fig.1) used for the space division multiplex wireless transmission (SDM), wherein said base station multi-beam antenna comprises a

plurality of base station antenna elements ( $M$  antenna elements, Fig.1), wherein each of said plurality of terminals comprises a terminal multi-beam antenna used for the space division multiplex wireless transmission (Fig.1, SDM), wherein said terminal multi-beam antenna comprises a plurality of terminal antenna elements ( $L$  antenna elements shown for each Mobile station, Page 784, Col 2 to Page 785, Col 1), and wherein said control unit is operable to orthogonalize a beam pattern of said base station multi-beam antenna, thereby controlling the space division multiplex wireless transmission (Pages 775 – 776, 785, multi-channel diagonalization).

Re claims 2, Wong teaches of wherein said control unit is operable to orthogonalize the beam pattern of said base station multi-beam antenna based on a plurality of transfer function values determining a radio-wave-propagation characteristic between said plurality of base station antenna elements and said plurality of terminal antenna elements (equation 5).

Re claims 3, Wong teaches of wherein a number of said base station antenna elements is greater than a maximum number of said terminal antenna elements among said plurality of terminals (Page 784, Col 2 to Page 785, Col 1).

Re claims 5, Wong teaches of wherein said control unit is operable to calculate eigenvectors of a channel matrix whose matrix elements are composed of the plurality of transfer function values, and wherein said control unit is operable to control a set of

weight to be imposed on said plurality of base station antenna elements using the eigenvectors of the channel matrix (Page 777, Col 2).

Re claims 6, Wong teaches of wherein said control unit is operable to calculate a plurality of diagonal elements ( $\Lambda$ , equation 11) of a channel matrix whose matrix elements are composed of the plurality of transfer function values ( $H_m$ ), and wherein said control unit is operable to control a set of weight to be imposed on said plurality of base station antenna elements using the plurality of diagonal elements of the channel matrix (Page 775, Col2, Section III and Page 776).

Re claim 13, Wong teaches of wherein said control unit is provided within said base station (Abstract and Page 773, Col 2, Paragraph 1).

Re claim 14, Wong teaches of a base station for a wireless communication system comprising said base station and a plurality of terminals, said base station and said plurality of terminals simultaneously performing space division multiplex wireless transmission of information using a same frequency, each of said plurality of terminals comprising a plurality of terminal antenna elements, said base station comprising: a base station multi-beam antenna comprising a plurality of base station antenna elements; and an antenna-controlling unit (Page 775, Col 2) operable to control the space division multiplex wireless transmission via said plurality of base station antenna elements, wherein said antenna-controlling unit is operable to calculate a plurality of

transfer function values determining a radio-wave-propagation characteristic between said plurality of base station antenna elements and said plurality of terminal antenna elements to orthogonalize a beam pattern of said base station multi-beam antenna based on the determined radio-wave-propagation characteristic (see claim 1).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was

not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 4, 7 – 9, 17 and 19 - 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wong in view of Garnier et al ("Performance of an OFDM-SDMA based System in a Time-Varying Multi-Path Channel", IEMN-DHS, ENIC, 2001 IEEE).

Re claim 4, Wong teaches all the limitations of claim 2 except of wherein each of said plurality of terminals is operable to transmit, to said base station, pilot signals to be used for estimation of a radio-wave-propagation characteristic between each of said plurality of terminals and said base station, wherein said base station is operable to receive the pilot signals, and wherein said control unit is operable to calculate the plurality of transfer function values based on the pilot signals.

Garnier teaches of a plurality of terminals (Fig.1) operable to transmit, to said base station (Fig.1), pilot signals to be used for estimation of a radio-wave-propagation characteristic between each of said plurality of terminals and said base station, wherein said base station is operable to receive the pilot signals, and wherein a control unit is operable to calculate the plurality of transfer function values based on the pilot signals (Page 1686, Col 1, last paragraph, Col 2, A.System Model and Page 1688, IV Channel Estimation Scheme).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used pilot signals for channel estimation for a reliable estimation.

Re claim 7, Wong teaches all the limitations of claim 2 except of when one of said plurality of terminals has moved, the one of said plurality of terminals is operable to transmit, to said base station, movement pilot signals to be used for estimating a radio-wave-propagation characteristic between said one of said plurality of terminals and said base station, said base station is operable to receive the movement pilot signals, said control unit is operable to re-calculate a plurality of transfer function values concerning the one of said plurality of terminals, and said control unit is operable to orthogonalize the beam pattern of said base station multi-beam antenna based on the plurality of re-calculated transfer function values.

Garnier teaches of when one of said plurality of terminals has moved (Doppler), the one of said plurality of terminals is operable to transmit, to said base station (Fig.1), movement pilot signals to be used for estimating a radio-wave-propagation characteristic between said one of said plurality of terminals and said base station (Page 1689, Col 2 and Page 1688), said base station is operable to receive the movement pilot signals, re-calculate a plurality of transfer function values concerning the one of said plurality of terminals (Page 1689, Col 2 to Page 1690, Col 1), and orthogonalize the beam pattern of said base station multi-beam antenna based on the plurality of re-calculated transfer function values (OFDM-SDMA, Fig.4).



It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used pilot signals for channel estimation for a reliable estimation and recalculate a plurality of transfer function values concerning the one of said plurality of terminals in order to decrease the bit-error-rate and maintain orthogonality.

Re claim 8, Wong and Garnier teach all the limitations of claim 7. Garnier also teaches of re-calculating a plurality of transfer function values concerning one or more un-moved terminals, the one or more un-moved terminals belonging to said plurality of terminals (Fig.6, *BER is a function of the channel length (proportional to the maximum delay spread)*).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have re-calculated a plurality of transfer function values concerning one or more un-moved terminals in order to compensate for high BER values due to delay spread.

Re claim 9, Wong and Garnier teach all the limitations of claim 7. Garnier also teaches of not re-calculating a plurality of transfer function values concerning one or more un-moved terminals, the one or more un-moved terminals belonging to said plurality of terminals (Fig.7, *BER is a function of the Doppler frequency, BER drops for a decreasing Doppler frequency*).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have not re-calculated a plurality of transfer function values concerning one or more un-moved terminals since an un-moved terminal would have a low BER and would decrease computational time.

Re claim 17, Wong teaches of a terminal for a wireless communication system comprising a base station and a plurality of terminals, each of said plurality of terminals being composed of said terminal, said plurality of terminals and said base station simultaneously performing space division multiplex wireless transmission of information using a same frequency with each other (Fig.1, Abstract), said terminal comprising: a terminal multi-beam antenna comprising a plurality of terminal antenna elements (Page 784, C.Discussion). However, Wong does not specifically teach of a pilot signal-generating unit operable to generate pilot signals used for estimation of a radio-wave-propagation characteristic between said base station and said terminal, wherein said terminal multi-beam antenna is operable to transmit to said base station the pilot signals generated by said pilot signal-generating unit.

Gamier teaches of a pilot signal-generating unit operable to generate pilot signals used for estimation of a radio-wave-propagation characteristic between said base station and said terminal, wherein said terminal multi-beam antenna is operable to transmit to said base station the pilot signals generated by said pilot signal-generating unit. (Page 1686, Col 1, last paragraph, Col 2, A.System Model and Page 1688, IV Channel Estimation Scheme).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used pilot signals for channel estimation for a reliable estimation.

Re claim 19, Wong teaches of a wireless communication method operable to simultaneously perform space division multiplex wireless transmission of information using a same frequency between a base station and a plurality of terminals, the base station comprising a base station multi-beam antenna including a plurality of base station antenna elements, each of the plurality of terminals comprising a terminal multi-beam antenna including a plurality of terminal antenna elements (see claim 1), said method comprising: communicating between at least one of the plurality of terminals and the base station via a plurality of propagation paths; calculating a plurality of transfer function values of a radio-wave-propagation characteristic between the plurality of base station antenna elements of the base station and the plurality of terminal antenna elements of the plurality of terminals; and orthogonalizing a beam pattern of the base station multi-beam antenna based on the plurality of transfer function values of the radio-wave-propagation characteristic (see claim 1). However, Wong does not specifically teach of transmitting pilot signals used for estimation of a radio-wave-propagation characteristic from each of the plurality of terminals to the base station; calculating a plurality of transfer function values of a radio-wave-propagation characteristic between the plurality of base station antenna elements of the base station

and the plurality of terminal antenna elements of the plurality of terminals based on the pilot signals.

Garnier teaches of transmitting pilot signals used for estimation of a radio-wave-propagation characteristic from each of the plurality of terminals to the base station; calculating a plurality of transfer function values of a radio-wave-propagation characteristic between the plurality of base station antenna elements of the base station and the plurality of terminal antenna elements of the plurality of terminals based on the pilot signals. (Page 1686, Col 1, last paragraph, Col 2, A.System Model and Page 1688, IV Channel Estimation Scheme).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used pilot signals for channel estimation for a reliable estimation.

Re claim 20, Wong teaches of wherein a number of the base station antenna elements is greater than a maximum number of the terminal antenna elements among the plurality of terminals (Page 784, Col 2 to Page 785, Col 1).

Re claim 21, Wong teaches of wherein said calculating including calculating eigenvectors of a channel matrix whose matrix elements are composed of the plurality of transfer function values, and wherein said orthogonalizing including controlling a set of weight to be imposed on the plurality of base station antenna elements using the eigenvectors of the channel matrix (Page 775 and 777, Col 2).

Re claim 22, Wong teaches of wherein said calculating including calculating a plurality of diagonal elements of a channel matrix whose matrix elements are composed of the plurality of transfer function values, and wherein said orthogonalizing including controlling a set of weight to be imposed on the plurality of base station antenna elements using the plurality of diagonal elements of the channel matrix (Page 775, Col2, Section III and Page 776).

Re claim 23, Wong and Garnier teach all the limitations of claim 19 as well as Garnier teaching of when one of said plurality of terminals has moved (Doppler), the one of said plurality of terminals is operable to transmit, to said base station (Fig.1), movement pilot signals to be used for estimating a radio-wave-propagation characteristic between said one of said plurality of terminals and said base station (Page 1689, Col 2 and Page 1688), said base station is operable to receive the movement pilot signals, re-calculate a plurality of transfer function values concerning the one of said plurality of terminals (Page 1689, Col 2 to Page 1690, Col 1), and orthogonalize the beam pattern of said base station multi-beam antenna based on the plurality of re-calculated transfer function values (OFDM-SDMA, Fig.4).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have used pilot signals for channel estimation for a reliable estimation and recalculate a plurality of transfer function values concerning the one of

said plurality of terminals in order to decrease the bit-error-rate and maintain orthogonality.

Claims 10 – 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wong and Garnier in view of Alexiou (US 2002/0098873).

Re claim 10, Wong and Garnier teach all the limitations of claim 7 except of wherein said control unit, utilizing mobility as a parameter indicating degree that one of said plurality of terminals has moved in space per unit time, is operable to determine priority of orthogonalization of said base station multi-beam antenna.

Alexiou teaches of beamforming in a SDMA base station wherein a control unit, utilizes mobility as a parameter indicating degree that one of said plurality of terminals has moved in space per unit time (Figs.2B – 2C, Paragraphs 0019 - 0020), is operable to determine priority of orthogonalization of said base station multi-beam antenna (*when the CIR (proportional to the angle spread) of one mobile user reaches the threshold, that mobile is allocated to a different channel*), Paragraph 0020).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have a control unit utilizing a parameter indicating degree that one of said plurality of terminals has moved in space per unit time to determine priority of orthogonalization in order to avoid unacceptable levels of interference and keep an acceptable angle spread that would maintain orthogonality.

Re claim 11, Wong, Garnier and Alexiou teach all the limitations of claim 10 as well as Alexiou teaching of determining the priority of orthogonalization of said base station multi-beam antenna. However, Alexiou does not specifically teach of determining the priority of orthogonalization of said base station multi-beam antenna such that priority of one of said plurality of terminals having certain mobility is higher than priority of another of said plurality of terminals having mobility greater than the certain mobility.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have a control unit utilizing a parameter indicating degree that one of said plurality of terminals has moved in space per unit time to determine priority of orthogonalization according to the levels of interference caused by the beams and prioritize starting with the terminals causing the highest interference according to the angle spread that causes severe disruption to orthogonality and would result in signal loss.

Re claim 12, Wong, Garnier and Alexiou teach all the limitations of claim 10 as well as Alexiou teaching wherein the mobility of said plurality of terminals is expressed in terms of respective identifiers (CIR threshold (*proportional to angle spread*)) given to said plurality of terminals, said plurality of terminals are operable to transmit to said base station the respective identifiers, said control unit is operable to receive the respective identifiers transmitted from said plurality of terminals, and said control unit is operable to determine the priority of orthogonalization of said base station multi-beam

antenna based on the respective identifiers received by said base station (see claim 10).

Claims 15 – 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wong in view of Alexiou (US 2002/0098873).

Re claim 15, Wong teaches all the limitations of claim 14 except of wherein said base station further comprising: an interference amount-estimating unit operable to estimate an interference amount in a pair of propagation paths between said plurality of terminals and said base station, wherein said antenna-controlling unit is operable to determine a beam pattern of said base station multi-beam antenna based on the interference amount estimated by said interference amount-estimating unit.

Alexiou teaches of a base station comprising: an interference amount-estimating unit operable to estimate an interference amount in a pair of propagation paths between said plurality of terminals and said base station (Paragraphs 0008, 0019 - 0020), wherein said antenna-controlling unit is operable to determine a beam pattern of said base station multi-beam antenna based on the interference amount estimated by said interference amount-estimating unit (Fig.2A-2C, Paragraphs 0019 – 0020 and 0040).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have estimated an interference amount in a pair of propagation paths in order to prevent angular unresolvability.



Re claim 16, Wong teaches all the limitations of claim 14 except of wherein said base station further comprising: a mobility-identifying unit operable to identify mobility of each of said plurality of terminals, the mobility indicating degree that one of said plurality of terminals has moved in space per unit time, wherein said antenna-controlling unit is operable to determine a beam pattern of said base station multi-beam antenna based on the mobility identified by said mobility-identifying unit (Page 775, Col2, Section III and Page 776).

Alexiou teaches of a base station comprising: a mobility-identifying unit operable to identify mobility of each of said plurality of terminals, the mobility indicating degree that one of said plurality of terminals has moved in space per unit time, wherein said antenna-controlling unit is operable to determine a beam pattern of said base station multi-beam antenna based on the mobility identified by said mobility-identifying unit.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have identified the mobility indicating degree that one of said plurality of terminals has moved in space per unit time in order to prevent angular unresolvability.

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wong and Garnier in view of A. Van Zelst ("*Space Division Multiplexing Algorithms*", 2000 IEEE).

Re claim 18, Wong and Garnier teach all the limitations of claim 17 as well as Wong further teaching wherein said terminal further comprising: an antenna-controlling unit operable to control wireless communications via said plurality of terminal antenna elements, and wherein said antenna-controlling unit is operable to cancel an interference wave (Page 776, Col 2), after said base station has orthogonalized a beam pattern (diagonalization, Page 775 - 776). However, Wong and Garnier do not specifically teach of cancelling the interference wave utilizing at least one of a zero forcing method and a maximum likelihood estimation method.

Van Zelst teaches of Space Division Multiplexing Algorithms where cancelling the interference wave utilizing at least one of a zero forcing method and a maximum likelihood estimation method (Pages 1219 - 1220).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have cancelled the interference wave utilizing at least one of a zero forcing method for its manageable complexity or a maximum likelihood estimation method for its best BER performance.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ARISTOCRATIS FOTAKIS whose telephone number is (571)270-1206. The examiner can normally be reached on Monday - Thursday 6:30 - 4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chieh M. Fan can be reached on (571) 272-3042. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Aristocratis Fotakis/

Examiner, Art Unit 2611

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/CHIEH M FAN/

Supervisory Patent Examiner, Art Unit 2611